

REMARKS

Claims 1, 3-5, 8, 10-12, 15, 17-18, and 21-26 are all the claims pending in the application. Claims 8, 10-12, and 25 stand objected upon informalities. Applicants respectfully traverse these rejections based on the following discussion.

I. The 35 U.S.C. §112, First Paragraph, Rejection

Claims 21-23 stand rejected under 35 U.S.C. §112, first paragraph. More specifically, the Office Action argues that claims 21, 22, and 23, which recite that the etching step and the additional patterning step both attack the substrate, “is not found to be supported in the specification as originally filed” (Office Action, p. 5, para. 3). Applicants submit that such features are illustrated in Figures 4-6 and the accompanying text. For example, **FIG. 5B** illustrates that the additionally patterning step attacks the substrate 110 **at the first region 114 and at the second region 116**. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw this rejection.

II. The Prior Art Rejections

Claims 1, 3-5, 15, 17-18, 24, and 26 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Dao, et al. (U.S. Patent No. 5,302,477), hereinafter referred to as Dao, in view of Schroeder, et al. (U.S. Publication No. 2003/0027057), hereinafter referred to as Schroeder, and in further view of either Levenson (U.S. Patent No. 6,251,549), Rolfson (U.S. Patent No. 6,395,432), or Applicant’s Admitted Prior Art.

Claims 8, 10-12, and 25 stand rejected under 35 U.S.C. §103(a) as unpatentable over Dao, in view of Schroeder, and in further view of Tzu, et al. (U.S. Patent No. 5,888,678), hereinafter referred to as Tzu. Claims 8, 10-12, and 25 stand rejected under 35 U.S.C. §103(a) as unpatentable over either Dao, in view of Schroeder, and in further view of Tzu and in further view of either Levenson, Rolfson, or AAPA. Claims 21 and 23 stand rejected under 35 U.S.C. §103(a) as unpatentable over either Dao, in view of Schroeder, in further view of either Levenson, Rolfson, or AAPA, in further view of Sandstrom (U.S. Publication No. 2002/0125443). Claim 22 stands rejected under 35 U.S.C. §103(a) as unpatentable over either Dao or Schroeder, in view of Tzu and in further view of either Levenson, Rolfson, or AAPA, and in further view of Sandstrom. Applicants respectfully traverse these rejections based on the following discussion.

Claims 1, 3-6, 15, and 17-19 stand rejected under 35 U.S.C. §102(b) as being anticipated by Dao, et al. (U.S. Patent No. 5,302,477), hereinafter referred to as Dao. Claims 1, 3-6, 15, and 17-19 stand rejected under 35 U.S.C. §102(e) as being anticipated by or, in the alternative, under 35 U.S.C. §103(a) as obvious over Schroeder, et al. (U.S. Publication No. 2003/0027057), hereinafter referred to as Schroeder. Claims 1, 3-6, 15, and 17-19 stand rejected under 35 U.S.C. §103(a) as being unpatentable over either Dao or Schroeder, in view of either Levenson (U.S. Patent No. 6,251,549), Rolfson (U.S. Patent No. 6,395,432), or Applicant's Admitted Prior Art. Claims 8 and 10-13 stand rejected under 35 U.S.C. §103(a) as unpatentable over either Dao or Schroeder, in view of Tzu, et al. (U.S. Patent No. 5,888,678), hereinafter referred to as Tzu. Claims 8 and 10-13 stand rejected under 35 U.S.C. §103(a) as unpatentable over either Dao or

Schroeder, in view of Tzu and in further view of either Levenson, Rolfson, or AAPA. Claims 21 and 23 stand rejected under 35 U.S.C. §103(a) as unpatentable over either Dao or Schroeder, in view of either Levenson, Rolfson, or AAPA, in further view of Sandstrom (U.S. Publication No. 2002/0125443). Claim 22 stands rejected under 35 U.S.C. §103(a) as unpatentable over either Dao or Schroeder, in view of Tzu and in further view of either Levenson, Rolfson, or AAPA, and in further view of Sandstrom. Applicants respectfully traverse these rejections based on the following discussion.

The claimed invention provides a method of forming a phase shift mask comprising performing a first patterning of an opaque layer to expose a first region of a substrate and performing additional patterning of the opaque layer to expose a second region of the substrate. In the rejection, the Office Action argues that the prior art of record discloses many features of the claimed invention. However, neither the region 24 nor the region 27 of Dao comprises an uninterrupted rectangular surface that lacks an intervening structure. Instead, the regions 24 and 27 each comprise a rectangular ring with an intervening structure in the middle thereof. Moreover, Schroeder does not disclose that a phase shift region is exposed via a patterning, wherein another phase shift region is subsequently exposed via an additional patterning. Rather, Schroeder merely discloses that the substrate is patterned and etched to produce phase shift regions having a predetermined depth in the top surface of the substrate. In addition, Levenson, Rolfson, Tzu, and Sandstrom teach away from the claimed invention. Furthermore, Applicants submit that because the patterning layer of Dao “must” be aligned in such a way that the resulting opening is formed as an intervening structure that prevents the phase-shifting

rim from being an uninterrupted rectangular structure, it would be improper to combine the uninterrupted rectangular surface of Schroeder with the structure of Dao. Therefore, as explained in greater detail below, Applicants respectfully submit that the prior art of record does not teach or suggest the claimed invention.

A. The rejection based on Dao

Applicants traverse this rejection because Dao fails to disclose that the first and second regions each comprise an uninterrupted rectangular surface. As illustrated in Figures 6A and 6B, the first region 114 comprises an uninterrupted rectangular surface. The second region 116 comprises a similar shape and size as the first region 114.

To the contrary, as illustrated in FIG. 4A and 10 of Dao, the region 24 comprises a rectangular ring with an intervening structure (i.e., the block 23) in the middle thereof. Similarly, the region 27 comprises a rectangular ring with an intervening structure (i.e., the opening 26) in the middle thereof.

Accordingly, Applicants submit that unlike the claimed invention, neither the region 24 nor the region 27 of Dao comprises an uninterrupted rectangular surface. Instead, the regions 24 and 27 each comprise a rectangular ring with an intervening structure in the middle thereof. Therefore, it is Applicants' position that Dao fails to teach or suggest the claimed feature "wherein said first region comprises an uninterrupted rectangular surface ... [and] said second region comprises a similar shape and size as said first region" as defined by independent claims 1 and 8. Moreover, Dao fails to teach or suggest the claimed feature "wherein said first regions comprise uninterrupted

rectangular surfaces ... [and] said second regions comprise similar shapes and sizes as said first regions” as defined by independent claim 15.

In addition, Applicants traverse the rejections because Dao fails to disclose that the first and second regions each comprise an uninterrupted rectangular surface, wherein the uninterrupted rectangular surface lacks an intervening structure. As illustrated in Figures 6A and 6B, the first region 114 and the second region 116 each comprise an uninterrupted rectangular surface that lacks an intervening structure.

To the contrary, as illustrated in FIG. 4A and 10 of Dao, the region 24 comprises a rectangular ring with an intervening structure (i.e., the block 23) in the middle thereof. Similarly, the region 27 comprises a rectangular ring with an intervening structure (i.e., the opening 26) in the middle thereof.

Accordingly, Applicants submit that unlike the claimed invention, neither the region 24 nor the region 27 of Dao comprises an uninterrupted rectangular surface that lacks an intervening structure. Instead, the regions 24 and 27 each comprise a rectangular ring with an intervening structure in the middle thereof. Therefore, it is Applicants’ position that Dao fails to teach or suggest the claimed feature “wherein said uninterrupted rectangular surface lacks an intervening structure” as defined by dependent claims 24 and 26. Moreover, it is Applicants’ position that Dao fails to teach or suggest the claimed feature “wherein said uninterrupted rectangular surfaces lack intervening structures” as defined by dependent claim 25.

B. The rejection based on Schroeder

Applicants respectfully traverse this rejection because, contrary to the position in the Office Action, Schroeder fails to teach an additional process for forming a second region, wherein the additional process enlarges an opening formed during a process for forming a first region.

Schroeder provides a limited disclosure relating to the formation of phase shift regions. Specifically, as discussed in paragraph 0042, the substrate 402 is patterned and etched to produce regions 440 having a predetermined depth in the top surface of the substrate 400. Regions 440 create phase shift regions where light will be shifted by 180 degrees. As also discussed in paragraph 0046, the assist edges 450 and 452 are preferably formed by patterning regions 440 having a predetermined depth into the top surface of the substrate 402. Alternatively, assist edges 450 and 452 may be formed by depositing additional transparent layers on the substrate 402, or depositing materials that provide the required phase shift, for example, other transparent materials.

No further description of the formation of phase shift regions is provided in Schroeder. Schroeder does not disclose that a phase shift region is exposed via a patterning, wherein another phase shift region is subsequently exposed via an additional patterning. Rather, Schroeder merely discloses that the substrate is patterned and etched to produce phase shift regions having a predetermined depth in the top surface of the substrate.

The Office Action argues that “[t]he method for making the PSM in Figure 6A *would be expected ... to involve* first patterning of an opening in the opaque layer ... and

additional patterning of the opaque layer to enlarge the opening that forms a second adjacent (non-PS) region 460 or 456” (Office Action, p. 5, para. 3 – p. 6, para. 1 (emphasis added)). However, the Office Action fails to provide any support within the prior art to maintain such an assertion. Applicants submit that there is nothing with Schroeder that discloses that a phase shift region is exposed via a patterning, and another phase shift region is subsequently exposed via an additional patterning.

Therefore, Schroeder does not teach the claimed feature of “performing a first patterning ... to expose a first region ... [and] performing additional patterning ... to expose a second region”, as defined by independent claims 1 and 15, and “performing a first patterning ... to expose first regions ... [and] performing additional patterning ... to expose second regions”, as defined by independent claim 8.

Furthermore, because Schroeder fails to teach an additional patterning that is subsequent to a first patterning, then Schroeder clearly does not teach that such an additional patterning would enlarge an opening formed in a first patterning. Thus, Schroeder does not teach or suggest the claimed feature “wherein said additional patterning enlarges an opening formed in said first patterning” as defined by independent claims 1 and 15, and “wherein said additional patterning enlarges openings formed in said first patterning” as defined by independent claim 8.

C. The rejection based on Dao or Schroeder in view of Levenson, Rolfson, or Applicants' admitted prior art (AAPA)

Applicants submit that Levenson is introduced by the Office Action for the sole purpose of illustrating first and second similarly shaped and sized regions that are adjacent one another. More specifically, the Office Action asserts that "neither Dao et al. or Schroeder et al. specifically teach a method of forming a PSM having adjacent first and second similarly shaped and sized rectangular 0° and 180° phase features ... However ... a PSM having book-matched adjacent first and second similarly shaped and sized rectangular regions is well known in the art of making PSMs, as exemplified by ... Levenson (Figures 9-11, col. 6 lines 53-61)" (Office Action, p. 7, para. 4 – p. 8, para. 1).

Applicants traverse the rejections because it would not have been obvious to combine Levenson with Dao or Schroeder. More specifically, Applicants submit that because Levenson teaches *simultaneously* forming the first and second regions, Levenson teaches away from the claimed invention. Independent claims 1 and 15 define "performing a first patterning ... to expose a first region ... and performing additional patterning ... to expose a second region".

To the contrary, as described in column 7, lines 63-64 of Levenson, the phase shift pattern 246 is formed in the material 242 by stamping, molding, or etching. As also described in column 7, line 65 – column 8, line 6, FIG. 25 shows a picture of construction of a generic substrate for a generic phase shift mask blank, whereby phase shift material 254 is deposited on the flat plate in the phase shift areas 256. Such deposition systems as plasma deposition, CVD deposition, and other deposition systems are known in the art.

Dissolving the resist 252 lifts off the material 254 deposited on top of the resist, and leaves material 254 in the phase shift areas 256.

Nothing within Levenson discloses exposing a first region and subsequently performing an additional patterning to expose a second region. In fact, the Office Action does not assert that such features are taught by Levenson. Instead, Levenson teaches *simultaneously* forming the first and second regions. Therefore, Applicants submit that it would not have been obvious to combine Levenson with Dao or Schroeder because Levenson teaches away from the claimed invention.

Applicants submit that Rolfson is introduced by the Office Action for the sole purpose of illustrating first and second similarly shaped and sized regions that are adjacent one another. More specifically, the Office Action asserts that “neither Dao et al. or Schroeder et al. specifically teach a method of forming a PSM having adjacent first and second similarly shaped and sized rectangular 0° and 180° phase features ... However ... a PSM having book-matched adjacent first and second similarly shaped and sized rectangular regions is well known in the art of making PSMs, as exemplified by ... Rolfson (Figure 12, col. 6 lines 28-36)” (Office Action, p. 7, para. 4 – p. 8, para. 1).

Applicants traverse the rejections because it would not have been obvious to combine Rolfson with Dao or Schroeder. More specifically, Applicants submit that because Rolfson teaches *simultaneously* forming the first and second regions, Rolfson teaches away from the claimed invention. Independent claims 1 and 15 define “performing a first patterning ... to expose a first region ... and performing additional patterning ... to expose a second region”.

To the contrary, Rolfson teaches *simultaneously* forming the first and second regions. Specifically, Figures 1, 2, 5, and 6 of Rolfson illustrate successive processing steps of forming alternating phase shift regions 32 and 34 (See “Brief Description of the Drawings” section, col. 3, lines 4-14). Particularly, phase shift regions 32 and 34 are formed simultaneously in the processing step shown in FIG. 5.

Nothing within Rolfson discloses exposing a first region and subsequently performing an additional patterning to expose a second region. In fact, the Office Action does not assert that such features are taught by Rolfson. Instead, Rolfson teaches *simultaneously* forming the first and second regions. Therefore, Applicants submit that it would not have been obvious to combine Rolfson with Dao or Schroeder because Rolfson teaches away from the claimed invention.

The Office Action asserts that “the particular configuration shown by instant Figure 5A or instant Figure 6A” is admitted as prior art by Applicants (Office Action, p. 7, para. 4 – p. 8, para. 1). Applicants respectfully disagree. More specifically, the Office Action argues that Figures 4A-6B show the same PSM structure as Figures 1A-3B (Office Action, p. 7, para. 4 – p. 8, para. 1). However, as provided in paragraph 0018 of Applicants’ disclosure, “FIGS. 1A-3B illustrate a methodology that is utilized to create a phase shift mask. This methodology is not necessarily well known; however, the invention is an improvement on this methodology”. Therefore, contrary to the position taken in the Office Action, Figures 5A and 6A do not disclose prior art structures.

D. The rejection based on Dao or Schroeder in view of Tzu

Applicants traverse this rejection because it would not have been obvious to combine Tzu with Dao or Schroeder because Tzu teaches away from the claimed invention.

First of all, Tzu teaches against patterning an opaque layer to expose the substrate. Such features are defined in independent claims 1 and 8 using the following language: “performing a first patterning of said opaque layer to expose a first region[s] of said transparent substrate ... and performing additional patterning of said opaque layer to expose a second region[s] of said transparent substrate”, and in independent claim 15 wherein the opaque layer is chrome and wherein the substrate is quartz.

Specifically, as clearly illustrated in FIGS. 5-6 of Tzu, after removal of the opaque layer 30, the substrate 20 remains *unexposed*. As discussed in column 4, lines 16-19 of Tzu, the first pattern 37 and the second pattern 39 are etched in the layer of opaque material 30, in this example chrome, using wet isotropic etching with an etchant such as CR-7 (HClO.sub.4, Cl(NH.sub.4).sub.2 (NO.sub.3).sub.6). However, as illustrated in FIG. 6, after etching the opaque material 30, the phase shifting material 26 remains over the substrate 20; and as such, the substrate 20 remains unexposed.

Therefore, Applicants submit that Tzu teaches against the claimed feature of performing a first patterning of said opaque layer to expose a first region of said transparent substrate and performing additional patterning of said opaque layer to expose a second region of said transparent substrate (independent claims 1, 8, and 15).

Secondly, Tzu teaches that the first and second regions of the substrate are formed *simultaneously*. Thus, Tzu teaches against the claimed feature of exposing a first region of the substrate via a first process, and subsequently exposing a second region of the substrate via an additional process. Such features are defined in independent claims 1, 8, and 15 using similar language.

As discussed in column 4, lines 16-23 of Tzu, after the opaque layer is etched, the first pattern 37 and the second pattern 39 are etched in the layer of attenuating phase shifting material 26, in this example MoSiON, using dry anisotropic etching with an etchant such as CF₄ and O₂ (FIG. 7).

Thus, the first pattern 37 and the second pattern 39 are formed *simultaneously* via an etching process of the phase shifting material 26. Therefore, Applicants submit that Tzu teaches against the claimed feature of “performing a first patterning ... to expose a first region[s] of said transparent substrate... [and] performing additional patterning ... to expose a second region[s] of said transparent substrate” as defined by independent claims 1, 8, and 15.

In addition, Applicants note that the second pattern 39 is not adjacent the first pattern 37 (i.e., portions of the opaque material 30 and the resist layer 32 separate the second pattern 39 from the first pattern 37). Therefore, there is a fundamental difference between the claimed invention and Tzu because Tzu teaches first and second regions that are separated by semiconductor components, whereas the claimed invention is different because the second region is adjacent the first region. As such, Tzu also teaches against the claimed feature “wherein said second region is adjacent said first region”, as defined

by independent claims 1 and 15, and “wherein said second regions are adjacent said first regions”, as defined by independent claim 8.

Moreover, as illustrated in FIGS. 10 and 11, the second pattern 39 does not have a similar shape and size as the first pattern 37. Specifically, as noted in the “Brief Description of the Drawings” section of Tzu (col. 3, lines 40-49), FIG. 10 shows a cross section view of the completed mask having a rim type attenuating phase shifting pattern (i.e., the second pattern 39) for *small* contact holes in one region of the mask and a binary mask pattern (i.e., the first pattern 37) for *large* contact holes in another region of the mask. Additionally, FIG. 11 shows a top view of a mask having a rim type attenuating phase shifting pattern (i.e., the second pattern 39) for *small* contact holes and a binary mask pattern (i.e., the first pattern 37) for *large* contact holes. Therefore, there is a fundamental difference between the claimed invention and Tzu because Tzu teaches different shaped and sized first and second regions, whereas the claimed invention is different because the second region comprises a similar shape and size as the first region.

Therefore, Tzu teaches against the claimed feature wherein “said second region comprises a similar shape and size as said first region, wherein said second region is adjacent said first region” as defined by independent claims 1 and 15, and wherein “said second regions comprise similar shapes and sizes as said first regions, wherein said second regions are adjacent said first regions”, as defined by independent claim 8.

E. The rejection based on Dao or Schroeder in view of Tzu and Levenson, Rolfson, or Applicants' admitted prior art (AAPA).

As more fully described above in section D, it would not have been obvious to combine Tzu with Dao or Schroeder because Tzu teaches away from the claimed invention. Moreover, as more fully described above in section C, it would not have been obvious to combine Levenson and/or Rolfson with Dao or Schroeder because both Levenson and Rolfson teach away from the claimed invention. Section C also describes that Figures 5A and 6A of Applicants' disclosure do not disclose prior art structures. Therefore, Applicants traverse this rejection because it would not have been obvious to combine Dao or Schroeder with Tzu and Levenson, Rolfson, or Applicants' admitted prior art (AAPA).

F. The rejection based on Dao or Schroeder in view of Sandstrom and Levenson, Rolfson, or Applicants' admitted prior art (AAPA).

Applicants submit that Sandstrom is introduced by the Office Action for the sole purpose of illustrating first and second patterning processes that both attack the substrate of the PSM. More specifically, the Office Action asserts that "neither Dao et al., Schroeder et al., Levenson, Rolfson, nor Applicant's admitted prior art specifically teach a method of forming a PSM in which the etching of a first PS region and the subsequent additional patterning of an adjacent second non-PS region both attack the substrate of the PSM ... Sandstrom teaches ... first etching step to pattern the PS region 327 and the

subsequent additional patterning by etching to form the second region 325 both attack the substrate of the PSM (Office Action, p. 10, para. 3 – p. 11, para. 1).

Applicants traverse the rejections because it would not have been obvious to combine Sandstrom with Dao or Schroeder and Levenson, Rolfson, or AAPA. More specifically, Applicants submit that because Sandstrom teaches exposing the region 327 (which the Office Action asserts teaches the second region of the claimed invention) by not patterning the layer 302, Sandstrom teaches away from the claimed invention. To the contrary, as defined in independent claims 1 and 15, the claimed invention includes “performing additional patterning of said opaque ... layer to expose a second region”.

Nothing within Sandstrom discloses exposing the region 327 (which the Office Action asserts teaches the second region of the claimed invention) by patterning an opaque layer. Instead, Sandstrom teaches exposing the region 327 by etching the substrate (See Sandstrom, FIGS. 3A – 3D and accompanying text). The layer 302, which overlays the substrate, is not affected by the etching processes (shown in FIGS. 3B and 3C). Therefore, Applicants submit that it would not have been obvious to combine Sandstrom with Dao or Schroeder and Levenson, Rolfson, or AAPA because Sandstrom teaches away from the claimed feature of “performing additional patterning of said opaque ... layer to expose a second region”.

G. The rejection based on Dao in view of Schroeder

Applicants further traverse the rejections because, contrary to the position in the Office Action, it would not have been obvious to combine Dao with Schroeder. The

Office Action expressly admits that “Dao et al. does not expressly require that the first rectangular region has an uninterrupted rectangular surface lacking an intervening structure” (Office Action, p. 5, para. 2). However, the Office Action argues that Schroeder discloses a rectangular first region 458 having an uninterrupted surface and an adjacent rectangular second region 460 having a similar shape (Office Action, pp. 5-7).

Applicants submit that Dao teaches away from the proposed combination of Dao and Schroeder. More specifically, referring to FIGS. 9 and 10, Dao teaches that the patterning layer 61 ***must*** be precisely aligned such that the phase-shifting rim 27 is centered about the opening 26.

Applicants submit that the opening 26 is the *intervening structure* within the phase-shifting rim 27 that prevents the phase-shifting rim 27 from being an uninterrupted rectangular structure. Further, Applicants submit that the positioning of the intervening opening 26 (within the phase-shifting rim 27) is a direct and necessary result of the ***required*** alignment of the patterning layer 61.

More specifically, as described in column 9, lines 3-9 of Dao, patterning layer 61 **must** be precisely aligned to ensure, for example, that phase-shifting rim 27 is centered about opening 26. Note that the left opening 62 of FIG. 9 is slightly smaller than the right opening 62, in order to allow for greater misalignment tolerance on those openings 62 which expose the chrome over regions corresponding to openings 23.

Accordingly, because the patterning layer “must” be aligned in such a way, the resulting opening 26 must be formed as an intervening structure that prevents the phase-shifting rim 27 from being an uninterrupted rectangular structure.

To attempt to combine the uninterrupted rectangular surface of Schroeder with the structure of Dao would be to ignore and disregard the direct and explicit teachings of Dao (i.e., that the “[p]atterning layer 61 must be precisely aligned to ensure, for example, that phase-shifting rim 27 is centered about opening 26” (Dao, col. 9, lines 3-5 (emphasis added))). Accordingly, it is Applicants’ position that it would not have been obvious to combine the structure of Schroeder with the teachings of Dao.

Therefore, it is Applicants’ position that the prior art of record do not teach or suggest many features defined by independent claims 1, 8, 15 and that such claims are patentable over the prior art of record. Further, it is Applicants’ position that dependent claims 3-5, 10-12, 17-18, and 21-26 are similarly patentable, not only because of their dependency from a patentable independent claims, but also because of the additional features of the invention they defined. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejections.

II. Formal Matters and Conclusion

In view of the foregoing, Applicants submit that claims 1, 3-5, 8, 10-12, 15, 17-18, and 21-26, all the claims presently pending in the application, are patentably distinct from the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary. Please charge any deficiencies and credit any overpayments to Attorney's Deposit Account Number 09-0456.

Respectfully submitted,

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